



SMART HOME AUTOMATION USING DIGITAL IMAGE PROCESSING TECHNIQUE

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Abstract

The process in which machines carry out any particular function without any human interference so as to reduce their workload is known as automation. Home Automation at present is considered to be the luxury entity but as time moves on it turns out to be an essential need. Prior gestures were used as nonverbal communication between the humans but now due to the advancement in the image processing technology we can use the same gestures to carry out the communication between the humans and machines and in our project, we used hand gestures to carry out the communication between humans and machines. At first the image is captured by the camera where we show the gestures of hand by count of the fingers whose ends are wrapped by the red colour tape and then the image is processed by the MATLAB. Once the MATLAB processes the image taken by the camera digitally and it will send certain serial commands to Arduino microcontroller which will provide suitable instructions to turn on / off the respective appliances. Fully functional real time home automation system has been developed and studied various effects of automation for various applications. System developed have been use full for senior and disabled people as developed system is very compact, safe and secure to operate.

Keywords: Arduino Microcontroller, Hand Gesture, Image processing algorithm, MATLAB software.

1. INTRODUCTION

Human-machine interfaces are constantly evolving in various fields with different processes involved to achieve user friendly remotely controlled applications. Today there is requirement to operate various appliances remotely. For senior people or the people who cannot operate instruments or visually impaired people there is requirement to operate various appliances with just by movement of hand [1][4]. Gesture recognition is the process by which gestures made by the user are used to convey the information for various device control applications. Within this group, the interfaces based on natural gestures of users allow converting these movements into commands for a system without contacting any surface [2]. The numerous benefits of today's home automation solutions include: convenience, safety and security, energy savings, and easily controllable. It can also improve the daily life of seniors and the disabled people.

Here in the project, we have MATLAB and Arduino which work together to do the Image Processing functions to control different appliances remotely with gesture movements [5][7].

Image processing

Image processing is a process in which the input will be images or the videos and the output will be the image with information embedded on it or the parameters of the image or videos will be extracted and presented in which the user understands it.

Digital Image Processing means processing an image acquired from the external or internal input device of the system which then performs the optimization. In other words, the systems follow the algorithms to trace the information in the image and present it informatively.

Digital Image is composed of a finite number of elements, each of which elements have a particular value at a particular location. These elements are referred to as picture elements, image elements and pixels. A Pixel is most widely used to denote the elements of a Digital Image.

Image processing mainly include the following steps:

1. Acquiring the image using image acquisition tools
2. Analysing and altering the image
3. Presenting the output with the images in which information is embedded or the report according to the analytics.

There are two types of methods available for image processing and they are analogue and digital image processing.

Analogue image processing is the method in which hardcopies of the images are taken and visual analysis is done and the results are obtained in the form of report.

Digital image processing is the method in which images acquired digitally using the computers. Those digital images undergo a process according to the algorithms and required information are extracted from it and presented according to the user needs it to be displayed.

2. PROPOSED SYSTEM OVERVIEW

The model uses primarily an Arduino Uno microcontroller which will be controlling the activity with image processing algorithm to process the acquired image for various activities.

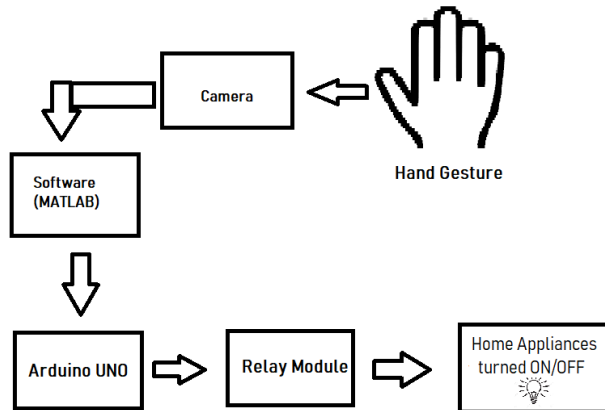


Figure 1 System blocks

Software Implementation

MATLAB is used in this project for the image processing. MATLAB is developed by MathWorks, which helps in solving mathematical problems. It does the manipulation of matrix and functions. It helps in data plotting, creating a user interface and many other things with the help of programs written in C, C++, Javaetc [5].

In MATLAB a digital image is represented as:

$$f(x, y) = \begin{bmatrix} f(1,1) & f(1,2) & \cdots & f(1,N) \\ f(2,1) & f(2,2) & \cdots & f(2,N) \\ \vdots & \vdots & \vdots & \vdots \\ f(M,1) & f(M,2) & \cdots & f(M,N) \end{bmatrix}$$

The MATLAB's Toolboxes which are used for this project are:

1. Image processing toolbox
2. Image acquisition toolbox

Image Processing Toolbox™ is a set of standard algorithms which are helpful in image processing. Many steps are included when we do image processing such as image segmentation and its enhancement, noise reduction and many more techniques which can be performed using this toolbox. The images supported by this toolbox can be in 2D or 3D [5].

Image Acquisition Toolbox™ is used to configure the camera used in this project. It helps in connecting and providing functions for hardware like camera's when connected to MATLAB [5]. It helps in developing a MATLAB code for the different types of acquisition. It also helps to develop codes for processes in the loop, background acquisition and also for hardware triggering among various multiple devices connected

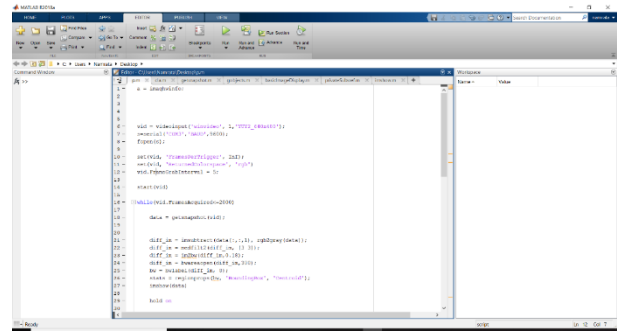


Figure 2 MATLAB Workspace

Hardware Implementation

Arduino UNO R3: Arduino is open-source platform with great ease of use for hardware as well as software. It is hardware board with a microcontroller ATmega328 AVR which can be programmed using Arduino software known as Arduino IDE [7]. This software helps to write and upload the code to the circuit board. The ATmega328 AVR microcontroller is a dual-inline-package which is removable from the circuit board [7].



Figure 3 Arduino microcontroller and sketch software



Figure 4 Relay module

Laptop Webcam: It is used to give commands (i.e., hand gesture) to the processing unit [4].

Relay Drivers: Relay is an electromagnetic switch. Microcontroller transmits the signal and the relay driver receives the signal which makes the bulb to turn ON [3]. It helps in connecting of a lower voltage working hardware device (in this project module an arduino) with the higher voltage input hardware devices (in this project

module a blub). The relays have two outputs- NO (Normally opened) and NC (Normally closed).

The MATLAB code is executed which triggers the webcam to turn on. The webcam Captures the gesture input video frames using the certain MATLAB functions and the properties of frame is set. The RED colour object in the frame is detected by subtracting the red component of the image from the captured grayscale image [5][6]. The following commands are used for the above process:

```
diff_im = imsubtract(data(:,:,1), rgb2gray(data));
```

Noise in the image is also filtered out using median filter command [5].

After this, the greyscale image is converted into binary image. This is done so that to obtain the interested part of the captured image that is then processed. It is done by with the help of function called im2bw [5]. Then the Image BOB Analysis is done. The BOB Analysis is used when an image has undergone a binarization processing [6]. It helps to detect features of the images such as number of fingers in our project model.

The Red part of the image is bounded into rectangular box and the count which is inside the loop function is sent to the arduino board using Serial Communication [6]. Status of prototypes architecture is monitored continuously using camera which uses Image acquisition toolbox of MATLAB [5].

3. OBSERVATIONS AND RESULTS

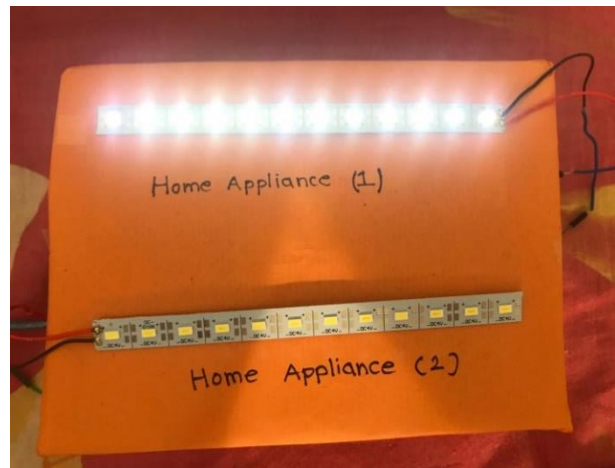
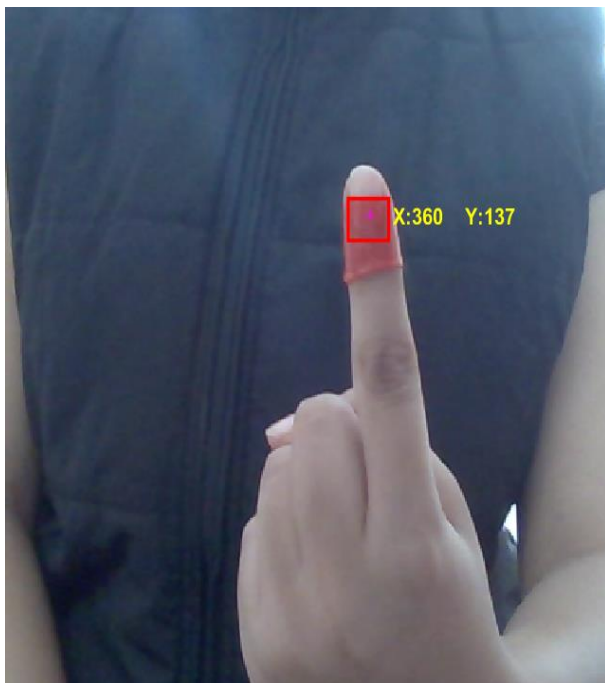


Figure 5 Single Finger Response

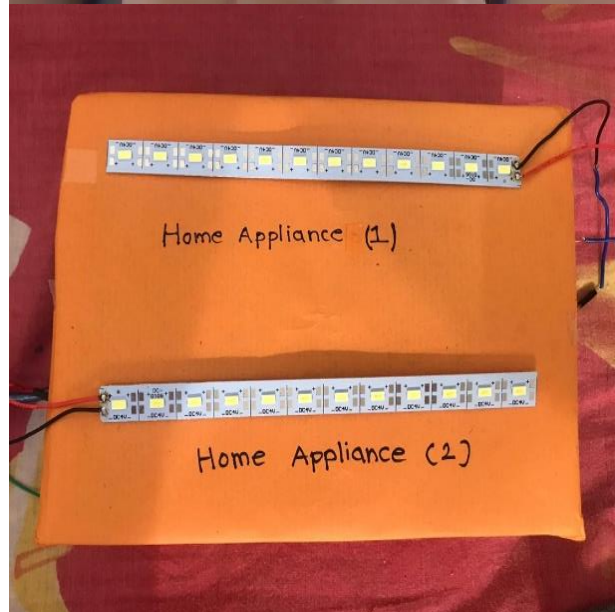
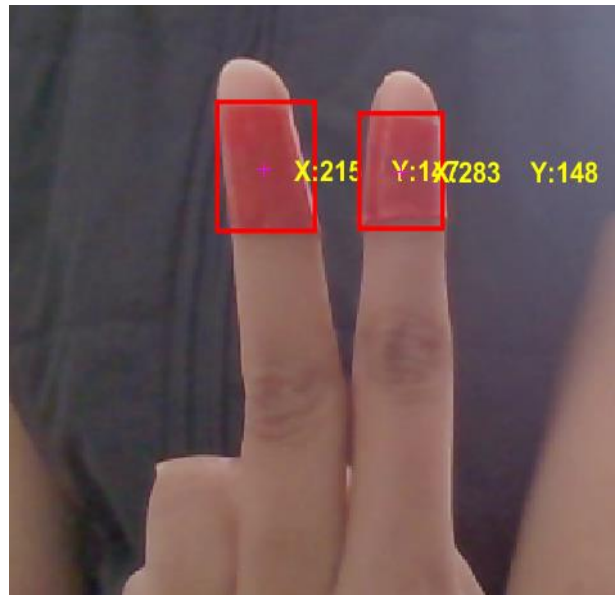


Figure 6 Two Fingers Repsonse

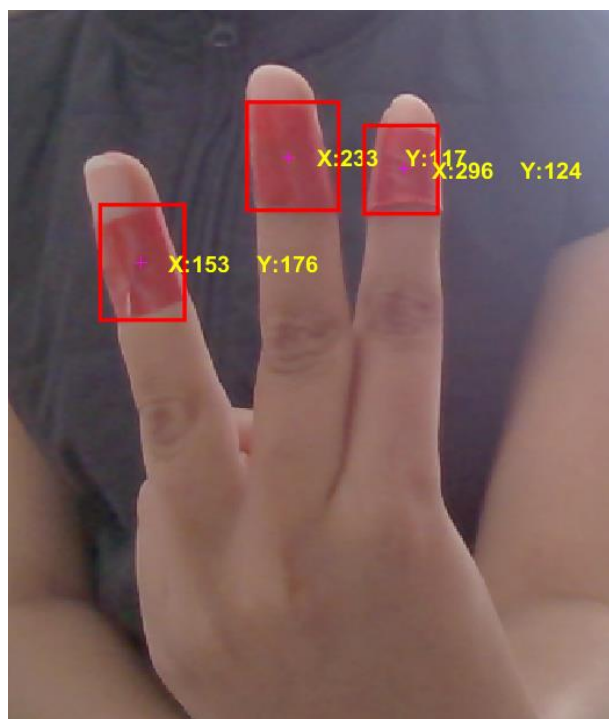


Figure 7 Three Fingers Response

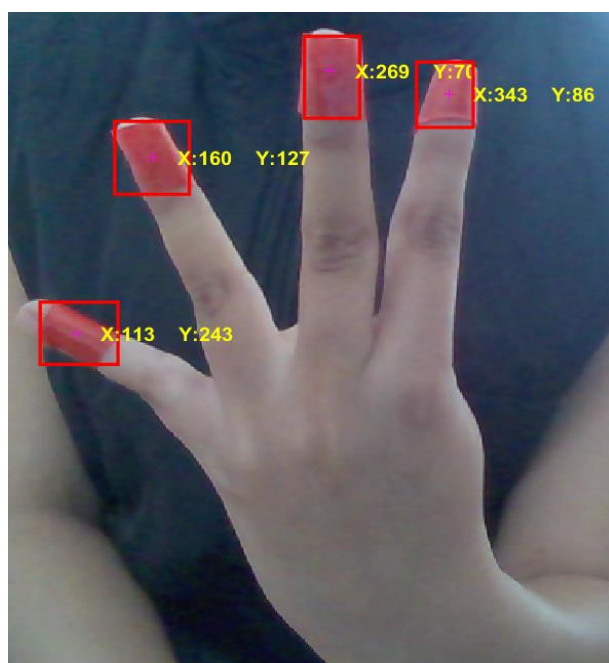


Figure 8 Four Fingers Response

In the above observation, the figure describes as follows:

Table 1 Observation and Results

Figure	Gesture Shown	Results Observerd
5(a)	1 Finger	Home Appliance (1) turned ON
5(b)	2 Fingers	Home Appliance (1) turned OFF
5(c)	3 Fingers	Home Appliance (2) turned ON
5(d)	4 Fingers	Home Appliance (2) turned OFF

4. CONCLUSION

In this paper, a home automation using hand gesture is a designed that is meant to be a fully-functional product which is useful in efficeintly translating the gestures of hand to electrical signals that can control the home appliances in real time. The motivation is to help the visually challenged people and the senior ones to control the electrical appliances more easily instead of old tradinatonal method where manual switches are used. The proposed system has the advantage of simple hardware and hand gestures, easy to operate and user friendly.

This was the basic module for higher Gesture control based home automation technology which can be further converted into a small compact wearable device using Sixth Sense Technology.

5. ACKNOWLEDGMENT

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